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Indian Standard
METHODS OF TEST FOR PETROLEUM AND ITS PRODUCTS
[P : 105]
ULTRAVIOLET (UV) ABSORBANCE AND ABSORPTIVITY OF PETROLEUM PRODUCTS

(First Reprint DECEMBER 1998)

UDC 665.6/.7 : 543.422.6

Adapted from ASTM Designation D 2008-80

1. SCOPE

1.1 This method covers the measurement of the ultraviolet absorption of a variety of petroleum products. It covers the absorbance of liquids or the absorptivity of liquids and solids, or both, at wavelengths in the region 220 to 400 nm of the spectrum.

1.2 The use of this method implies that the conditions of measurement — wavelength, solvent if any, sample path length and sample concentration — are specified by reference to one of the examples of the application of this method in the appendices or by a statement of other conditions of measurement.

1.3 Examples of the application of this method are the determination of the absorbance of white mineral oil, the absorptivity of refined petroleum wax, the absorptivity of petrolatum and the absorptivity of nonstaining rubber processing or extender oils (*see* Appendices A, B, C and D).

2. OUTLINE OF THE METHOD

2.1 The ultraviolet absorbance of a liquid is determined by measuring the absorption spectrum of the undiluted liquid in a cell of known path length under specified conditions.

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2.2 The ultraviolet absorptivity of a solid or a liquid is determined by measuring the absorbance, at specified wavelengths, of a solution of the liquid or solid at known concentration in a cell of known path length.

3. SIGNIFICANCE

3.1 The absorbance of liquids and the absorptivity of liquids and solids at specified wavelengths in the ultraviolet are useful in characterizing petroleum products.

4. TERMINOLOGY

4.0 For the purpose of this standard the following definitions and symbols shall apply.

4.1 Absorbance, A — The logarithm to the base 10 of the reciprocal of the relative transmittance (T).

$$A = \log_{10} (1/T) = - \log_{10} T$$

NOTE — Absorbance expresses the excess absorption over that of a specified reference or standard. It is implied that compensation has been affected for reflectance losses, solvent absorption losses, and refractive effects, if present, and that attenuation by scattering is small compared with attenuation by absorption.

4.2 Absorptivity, a — the absorbance divided by the product of the concentration of the substance and the sample path length, $a = Af/bc$. The units of b and c, or of a, shall be specified.

NOTE — The recommended unit for a is litres per gram-centimetre.

4.3 Concentration, c — the quantity of the substance contained in a unit quantity of sample. In this method it is expressed in grams per litre.

4.4 Dilution Factor, f — the ratio of the volume of a diluted solution to the volume of the original solution containing the same quantity of solute as the diluted solution.

4.5 Sample Path Length, b — the symbol for sample path length is b.

NOTE — The recommended unit for path length is centimetres.

5. APPARATUS

5.1 Spectrophotometer — Equipped to handle liquid samples in cells having sample path lengths up to 10 cm. The instrument shall be capable of measuring absorbance with a repeatability of ±1·0 percent or better from an average at the 0·4 absorbance level in the spectral region of measurement between 220 nm and 400 nm with a spectral band width of 2 nm or less. Wavelength measurements shall be repeatable within ±0·2 nm.

NOTE — Measurements requiring the use of cells having sample path lengths less than 10 cm may be made on instruments equipped to handle only these cells. It is desirable, but not essential that the instrument be automatic recording when an extended range of the spectrum shall be examined. Manually operated spectrometers are suitable for obtaining absorbance readings at specified analytical wavelengths. If measurements are to be made at temperatures higher than room temperature, the spectrophotometer shall be provided with a means for maintaining cells at the selected test temperature.

5.2 One or more pairs of fused silica cells having sample path lengths in the range 0·100 0 to 10·00 cm are required. Sample path lengths shall be known to be within ±0·5 percent of nominal sample path length or better. Unless otherwise specified, 1 cm sample path length cells are recommended.

6. REAGENTS AND MATERIALS

6.1 Solvents

6.1.1 Iso-*Octane* [*Danger — Extremely flammable, harmful, if inhaled* (*see also Appendix E*)] — for use as the preferred spectroscopic solvent.

NOTE — Technical *iso*-octane is a satisfactory base stock for the preparation of spectroscopic solvent. Allow about 4 or 5 litres of this material to percolate through a column of activated silica gel 50 to 75 mm in diameter and 0·6 to 0·9 m in depth. Collect only the portion of the solvent that has an absorbance less than 0·05 over the entire spectral range 240 to 300 nm in a 1 cm cell when compared to water in a 1 cm cell.

6.1.2 *Decahydronaphthalene* (*Decalin*) [*Caution — Combustible, vapour harmful* (*see also Appendix E*)] — for use as the first alternative spectroscopic solvent.

NOTE — The silica gel percolation described in note under **6.1.1** is also recommended for the preparation of decahydronaphthalene as a spectroscopic solvent.

7. SAMPLING

7.1 Precautions shall be taken to ensure that a representative sample is obtained since ultraviolet absorption is very sensitive to small amounts of extraneous material contaminating the sample through careless handling. If possible, samples should be obtained from packaged products that have been protected from accidental contamination.

7.2 If the petroleum product to be tested is available as a bulk sample weighing more than 1 kg, a representative sample of approximately 1 kg shall be taken and made homogeneous.

7.3 If the petroleum product to be tested is available as a bulk sample weighing less than 1 kg but more than 100 g the entire sample shall be taken and made homogeneous.

7.4 In no case shall a sample of a petroleum product be considered representative if it weighs less than 100 g. However, measurements may be made on samples weighing less than 100 g if the origin sampling procedure, and basis of selection of the sample are recorded and reported as part of the results of this method.

8. DETERMINATION OF ABSORBANCE OF UNDILUTED LIQUIDS

8.1 Procedure — Fill a 1·0 cm reference cell with water. Make sure the cell windows are clean. Position the cells in the cell compartment of the spectrophotometer and obtain absorbance at the wavelengths of interest within the range 220 to 400 nm. This data gives a cell correction for the 1·0 cm cell. It may be ignored at all wavelengths where the absorbance is between — 0·01 and +0·01. After the cell correction data has been determined, the cells shall be designated as reference and sample cells and shall be maintained as such.

8.1.1 Fill a 1·0 cm sample cell with undiluted liquid sample (after complete removal of water) and obtain the absorbance as described in **8.1**.

NOTE — The absorbance-wavelength curve may be conveniently obtained starting at the long wavelength end of the spectrum. Readings shall be made at successively shorter wavelengths until an absorbance greater than 1·0 is obtained. When using automatic recording instruments (recommended) it is desirable to make the cell correction scan and the sample scan on the same chart. In the longer wavelength region of the spectrum, it may be desirable to use longer path length cells than those recommended to obtain readable absorbances. In the shorter wavelength region of the spectrum, absorbances may become too high for accurate measurement in the 0·1 cm cell. These values shall be recorded only as greater than 1·0. If numerical values are required it is recommended that absorptivity be measured rather than absorbance.

8.1.2 Repeat **8.1** and **8.1.1** using a 0·1 cm cell in place of the 1·0 cm cell (*see* Note under **8.1.1**).

8.2 Calculation — The absorbance of undiluted liquid sample at each analytical wavelength is given as follows:

$$A = A_L - A_C$$

where

A = absorbance of undiluted liquid sample;

A_L = chart or absorbance reading of sample filled sample cell, and

A_C = chart or absorbance reading of water-filled sample cell.

8.2.1 The absorbance per centimetre path length is equal to A/b, where b is the sample cell path length in centimetres.

8.3 Report

8.3.1 If the numerical value of the absorbance of an undiluted liquid sample is reported, it shall be accompanied by a statement of the wavelength of measurement and the sample path length expressed in centimetres.

8.3.2 If the numerical value of the absorbance per centimetre of an undiluted liquid sample is reported, it shall be accompanied by a statement of the wavelength of measurement.

9. DETERMINATION OF ABSORPTIVITY OF SOLIDS AND LIQUIDS

9.1 Outline of the Method

9.1.1 The range of absorptivities for petroleum products is very wide. Probably most absorptivities of interest would fall in the range 10^{-4} to 10 litres per gram-centimetre.

9.1.2 In determining absorptivities it is necessary to measure absorbances in the range 0·1 to 1·0 for optimum results. This is done by preparing solutions and selecting cells of sample path length to give absorbances in the 0·1 to 1·0 range. For an individual petroleum product the absorptivity may change so rapidly with wavelength that it is necessary to prepare several solutions in order to cover the required wavelength interval. Consideration shall be given to the selection of solvent, the selection of concentration levels, and the selection of sample path lengths to obtain optimum results.

9.2 Selection of Solvent

9.2.1 The choice of solvent is dictated by the solubility of the petroleum product and the transparency of the solvent in the region of interest.

9.2.2 *iso*-octane shall be used unless restricted by solubility requirements.

9.2.3 Decahydronaphthalene shall be the first alternative solvent to be used if the sample is not sufficiently soluble in *iso*-octane.

9.2.4 If neither *iso*-octane nor decahydronaphthalene will dissolve a sufficient quantity of sample to prepare the required solution, then any other suitable solvent shall be selected. For the purpose of this method a solvent shall be considered to have sufficient "spectroscopic purity" when its absorbance in a 1 cm cell, using reagent water in a 1 cm cell as a reference, is less than 0·05 at all wavelengths where a sample absorbance is to be measured in a 1 cm cell. Cyclohexane (*Danger* — Extremely flammable. Harmful if inhaled. *See* also Appendix E), carbon tetrachloride (*see* Appendix E), chloroform (*see* Appendix E), and the alcohols are useful alternative spectroscopic solvents.

9.3 Selection of Solution Concentration

9.3.1 The initial solution of the sample shall be at a concentration high enough to provide measurable absorbance (0·1 to 1·0) at the wavelength of weakest absorption to be measured but not over 40 g/litre and necessarily within the solubility limitations of the solvent.

NOTE — The lowest concentration that may be prepared conveniently in the initial solution is about 1 g/litre. If the sample is not sufficiently soluble at room temperature to prepare such a solution, then proceed at elevated temperature in accordance with **9.6**.

9.3.2 Table 1 (*see* page 8) lists four recommended concentration levels for the initial solution and the required sample mass and solution volumes. Column 4 gives the range of absorptivities that will give absorbance readings between 0·1 and 1·0 when the solution is measured in a 1 cm cell.

9.3.3 Select from Table 1 the concentration required to measure the lowest absorptivity of interest in the sample. Note the recommended sample mass and solution volumes. These shall be used in preparing the initial solution of the sample.

9.3.4 If concentration levels lower than 1 g/litre are required because absorptivities at the wavelengths of interest exceed 1, prepare an initial solution at the 4 g/litre level (Table 1) and dilute as follows: pipette 1 to 10 ml of the initial solution into a 25 to 100-ml volumetric flask to obtain a dilution factor in the range 2·5 to 100.

NOTE — For example, 1 ml of the initial solution (4 g/litre) pipetted into a 25-ml volumetric flask, which is then filled to the mark with solvent and shaken, will give a dilution factor of 25 and a concentration level of 0·160 g/litre in the first dilution. Repeating this procedure on the first dilution would produce a second dilution containing 0·006 4 g/litre. The dilution factor for the second dilution would be 625. Dilution factors shall be selected to obtain an absorbance reading in the range 0·1 to 1·0 at the wavelength of measurement.

9.4 Selection of Sample Path Length

9.4.1 Unless otherwise specified in a particular application of this method, the recommended sample path length shall be 1·0 cm, and the alternative sample path length shall be 10·0 cm.

NOTE — The procedures given in clause **9.5** and **9.6** were written assuming the use of the recommended sample path length, 1 cm, and the use of the alternative sample path length, 10·0 cm. If in a particular application of this method different sample path lengths are specified, the smaller shall become the recommended sample path length and shall be used where a 1·0-cm cell is specified. The larger shall become the alternative sample path length and shall be used where a 10·0-cm cell is specified.

9.5 Procedure at Room Temperature

9.5.1 Weigh by difference the recommended sample mass into the volumetric flask (*see* Table 1). Add solvent to partially fill the flask and shake to dissolve the sample. Fill to the mark with solvent.

NOTE — If sample does not go into solution rapidly, it may be necessary to warm the solution by heating the flask under warm tap water. When the sample has dissolved, dilute to volume and shake to make homogeneous. Cool to room temperature. Add solvent to the mark.

9.5.2 Fill a 1·0-cm sample cell with the initial solution or dilution to be measured. Fill a 1·0-cm reference cell with solvent. Make sure the windows are clean. Position the cell in the cell compartment of spectrophotometer and measure the absorbance of the sample at wavelengths of interest within the range 220 to 400 nm.

9.5.3 If the absorbance reading in the 1·0-cm cell is less than 0·1 at one or more of the wavelengths of interest, repeat **9.5.2** using a pair of 10-cm cells to obtain an absorbance reading in the 0·1 to 1·0 range.

9.5.4 If the absorbance reading in the 1·0-cm cell is greater than 1·0 at one or more of the wavelengths of interest, dilute to obtain absorbances in the readable range (0·1 to 1·0). Dilution factors of 2·5 to 100 may be obtained by pipetting volumes of 1 to 10 ml of the initial solution into 25 to 100-ml volumetric flask and filling to the mark with solvent.

9.5.5 Determine the cell correction by measuring the absorbance of the solvent-filled sample cell compared to the solvent-filled reference cell.

9.6 Procedure at Elevated Temperature

9.6.1 If it is not possible to obtain a homogeneous solution of the sample at room temperature in the recommended solvents (*see* Note under **9.4.1**), it will be permissible to determine the absorbance at a test temperature high enough to ensure solubility, but not exceeding 66°C.

9.6.2 Weigh by difference the recommended sample mass into a clean, calibrated volumetric flask and record the mass to the nearest 0·1 mg (*see* Table 1).

9.6.3 Partially fill the flask with solvent, and place the flask in a water bath at the test temperature. When the sample is completely dissolved, dilute to volume using solvent at the test temperature. Shake to make homogeneous and bring to the test temperature in a water bath.

9.6.4 Insert the flask into the spectrophotometer cell holders capable of maintaining the sample cell and the reference cell at the desired test temperature.

NOTE — Proper precautions shall be taken to ensure that the temperature of the solution at the time of absorbance measurement is within ±1°C of the test temperature at which the solution was diluted to volume.

TABLE 1 RECOMMENDED SAMPLE MASS AND SOLUTION VOLUMES FOR INITIAL SOLUTION OF SAMPLE

(*Clause* 9.3, 9.5 *and* 9.6)

CONCENTRATION g/litre	SAMPLE MASS mg*	VOLUMETRIC FLASK, ml	RANGE OF ABSORPTIVITIES MEASURABLE IN 1 cm CELL†
(1)	(2)	(3)	(4)
40	1 000	25	0·002 5 to 0·025 0
10	250	25	0·010 to 0·100
4	100	25	0·025 to 0·250
1	100	100	0·100 to 1·000

*The sample should be weighed to the nearest 0·1 mg and be within ±5 percent of the nominal mass listed.

†If a 10 cm cell were used, the range of absorptivities measurable would be lowered by a factor of 10.

9.6.5 Transfer a sample of the solution (hypodermic syringe heated to the test temperature is convenient) into a 1·0-cm sample cell previously heated to the test temperature. Fill a 1·0-cm reference cell with solvent at the test temperature in a similar manner. Stopper the cells firmly. Make sure the cell windows are clean. Position the cells in the cell compartment of the spectrophotometer. Allow enough time for temperature equilibrium and obtain the absorbance as required at wavelengths of interest within the range 220 to 400 nm.

9.6.6 If the absorbance reading in the 1·0-cm cell is less than 0·1 at one or more of the wavelengths of interest, repeat **9.6.5** using a pair of 10-cm cells to obtain an absorbance reading in the 0·1 to 1·0 range.

9.6.7 If the absorbance reading in the 1·0-cm cell is greater than 1·0 at one or more of the wavelengths of interest, prepare a second initial solution at a lower concentration level selected from Table 1. If this is not possible, repeat **9.6.5** using a pair of 0·1 or 0·5 cm cells to obtain an absorbance reading in the 0·1 to 1·0 range.

9.6.8 Determine a cell correction by using solvent in the sample cell and compare it to the solvent-filled reference cell.

9.7 Calculation

9.7.1 The absorptivity, a, of a solid or liquid sample at the specified wavelength is given as follows:

$$a = Af/cb$$

where

A = absorbance of sample solution at specified wavelength minus cell correction,

b = path length of sample cell in centimetres,

c = concentration of sample in grams per litre of the initial solution, and

f = dilution factor, the ratio of the volume of the diluted solution to the volume of the original solution containing the same quantity of solute as the diluted solution. For the initial solution, $f = 1$.

9.8 Report

9.8.1 Numerical values of absorptivities are reported along with a statement of the wavelength, solvent, concentration, and cell path length used in obtaining the absorbance measurement.

9.9 Precision And Accuracy

9.9.1 The precision and accuracy shall be determined by cooperative testing on representative types of petroleum products.

APPENDIX A

(*Clause* 1.3)

ABSORBANCE OF WHITE MINERAL OIL

A-1. SCOPE

A-1.1 As an example of the application of the general method for determining the absorbance of undiluted liquid samples, the absorbance of white mineral oil shall be determined at 275 nm in a 0·1-cm cell in the region 295 to 299 nm and 300 to 400 nm in a 1-cm cell. The absorbances of the white mineral oil shall be compared with a standard reference absorption of a naphthalene solution at 275 nm.

A-2. REFERENCE STANDARD

A-2.1 Naphthalene — (*See* IS : 539-1974*).

A-3. STANDARD REFERENCE ABSORPTION

A-3.1 The standard reference absorption shall be absorption at 275 nm in a 1-cm cell of a solution containing 7 mg/litre of naphthalene in *iso*-octane.

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*Specification of naphthalene (*second revision*).

A-3.2 Since it is not convenient to prepare a solution containing exactly 7 mg of naphthalene per litre of *iso*-octane, the absorptivity of a solution containing approximately this amount shall be measured and the standard reference absorption calculated. The absorptivity of naphthalene at 275 nm is approximately 43.

A-3.3 Measure the absorptivity of a solution of naphthalene containing between 6 and 8 mg/litre in *iso*-octance in a 1-cm cell. Prepare the solution in accordance with **9.3.4** using a dilution factor of 625, and measure its absorbance at 275 nm in accordance with **9.5**.

A-4. PROCEDURE

A-4.1 Proceed in accordance with **8.2** using white mineral oil as the sample. For white mineral oil, scan the region 400 to 250 nm.

A-5. CALCULATION

A-5.1 Calculate the absorptivity of naphthalene at 275 nm as described in **9.7**.

A-5.2 Calculate the standard reference absorption as follows:

$$\text{Standard reference absorption} = 0{\cdot}007\, a$$

where

0·007 = concentration in grams per litre of naphthalene solution defining the standard reference absorption, and

a = measured absorptivity of naphthalene at 275 nm.

A-5.3 Proceed in accordance with **8.2** to determine the absorbance of mineral oil at 275 nm in the 0·1-cm cell, the maximum absorbance in the region 295 to 299 nm in the 1·0-cm cell, and the maximum absorbance in the region 300 to 400 nm in the 1·0-cm cell.

A-6. REPORT

A-6.1 Report the standard reference absorbance.

A-6.2 Report the mineral oil absorbance as follows:

Wavelength	*Cell Length*	*Absorbance*
nm	cm	
275	0·1	…………, *Max*
295 to 299	1·0	…………, *Max*
300 to 400	1·0	…………, *Max*

A.7. PRECISION

A-7.1 The following criteria shall be used for judging the acceptability of results (95 percent confidence).

A-7.1.1 *Repeatability* — Duplicate results by the same operator should be considered suspect if they differ by more than the following amounts:

Wavelength, nm	*Repeatability*
275	0·008
295 to 299	0·019
300 to 400	0·014

A-7.1.2 *Reproducibility* — The result submitted by each of two laboratories should be considered suspect if the two results differ by more than the following amounts:

Wavelength, nm	*Reproducibility*
275	0·053
295 to 299	0·071
300 to 400	0 080

APPENDIX B

(*Clause* 1.3)

ABSORPTIVITY OF REFINED PETROLEUM WAX

B-1. SCOPE

B-1.1 As an example of the application of the general method for determining the absorptivity of solids and liquids, the absorptivity of refined petroleum wax is determined at 290 nm. Under the conditions specified, this method covers the determination of absorptivities in the range 0·01 to 1·0 litres/g cm.

B-2. PROCEDURE

B-2.1 Follow the general method given in **9.5** for determining absorptivity at room temperature. The recommended sample mass shall be 100 mg dissolved in 100 ml of *iso*-octane. Make absorbance measurements at 290 nm in 1·0 and 10·0-cm-cells as described in **9.5**.

B-2.2 If the sample is not sufficiently soluble in *iso*-octane, use the alternative solvent decahydronaphthalene.

B-2.3 If the sample is not sufficiently soluble at room temperature in either *iso*-octane or decahydronaphthalene continue as described in **9.6.**

B-3. CALCULATION

B-3.1 The absorptivity, a, of a wax is given by the equation:

$$a = Af/cb \text{ (\textit{see} \textbf{9.7.1})}$$

B-4. REPORT

B-4.1 Report the absorptivities of waxes in the range 0·01 to 1·0 to two significant figures. Report absorptivities less than 0·01 as less than 0·01. Report absorptivities greater than 1·0 as greater than 1·0.

B-5. PRECISION

B-5.1 The following criteria should be used for judging the acceptability of results (95 percent confidence).

B-5.1.1 *Repeatability* — Duplicate results by the same operator should be considered suspect if they differ by more than the following amounts:

Absorptivity	*Repeatability*
0·02	—
0·15	0·02
0·30	0·02

B-5.1.2 *Reproducibility* — The results submitted by each of two laboratories should be considered suspect if the two results differ by more than the following amounts:

Absorptivity	*Reproducibility*
0·02	—
0·15	0·05
0·30	0·05

APPENDIX C

(*Clause* 1.3)

ABSORPTIVITY OF PETROLATUM

C-1. SCOPE

C-1.1 As an example of the application of the general method for determining the absorptivity of solids and liquids, the absorptivity of petrolatum shall be determined at 290 nm. Under the conditions specified, this method covers the determination of absorptivities in the range 0·02 to 5·0 l/g cm.

C-2. PROCEDURE

C-2.1 Follow the general method given in **9.5** for determining absorptivity at room temperature. The recommended sample mass shall be 100 mg dissolved in 100 ml of *iso*-octane. Absorbance measurements shall be made at 290 nm in 1·0 and 10·0-cm cells as described in clause **9.5.** If a dilution is required as described in **9.5.4**, a dilution factor of 5 (5 to 25 ml) would be adequate for measuring absorptivities up to 5·0.

C-2.2 If the sample is not sufficiently soluble in *iso*-octane, the alternative solvent decahydronaphthalene shall be used.

NOTE — Carbon tetrachloride is also a good solvent for many petrolatums and may be used when the sample is not sufficiently soluble in *iso*-octane or decahydronaphthalene.

C-3. CALCULATION

C-3.1 The absorptivity, a, of the petrolatum at 290 nm is given by the equation:

$$a = Af/cb$$ (*see* **9.7.1**)

C-4. REPORT

C-4.1 Report absorptivities of petrolatums in the range 0·02 to 5·0 to two significant figures. Report absorptivities less than 0·02 as less than 0·02. Report absorptivities greater than 5·0 as greater than 5·0.

C-5. PRECISION

C-5.1 The following criteria should be used for judging the acceptability of results (95 percent confidence).

C-5.1.1 *Repeatability* — Duplicate results by the same operator should be considered suspect if they differ by more than 0·01 at the level of 0·5.

C-5.1.2 *Reproducibility* — The results submitted by each of two laboratories should be considered suspect if the two results differ by more than 0·05, at the level of 0·5.

APPENDIX D

(*Clause* 1.3)

ABSORPTIVITY OF NON-STAINING RUBBER PROCESSING OR EXTENDER OILS

D-1. SCOPE

D-1.1 As an example of the application of the general procedure for determining the absorptivity of solids and liquids, the absorptivity of non-staining rubber extender and processing oils is determined at 260 nm. Under the conditions specified, this method determines the absorptivities in the range 0·10 to 20 l/g cm.

D-2. PROCEDURE

D-2.1 Follow the general procedure of clause **9.5** for determining absorptivity at room temperature. The recommended sample mass is 100 mg dissolved in 100 ml of "spectro grade" *iso*-octane. Make absorbance measurements at 260 nm in a 1·0-cm cell as described in **9.5**.

D-2.2 If a dilution is required by **9.5.4** a dilution factor of 5 (5 to 25 ml) will be adequate for measuring absorptivities up to 5·0; a dilution factor of 20 (5 to 100 ml) will be adequate for measuring absorptivities between 5·0 and 20·0.

D-3. CALCULATION

D-3.1 The absorptivity, a, of the oil at 260 nm is given by the equation:

$$a = Af/cb \quad (\textit{see } \mathbf{9.7.1})$$

D-4. REPORT

D-4.1 Report absorptivities of oils in the range 0·10 to 20 to two significant figures. Report absorptivities less than 0·10 as less than 0·10. Report absorptivities greater than 20 as greater than 20.

D-5. PRECISION

D-5.1 The following criteria should be used for judging the acceptability of results (95 percent confidence).

D-5.1.1 *Repeatability* — Duplicate results by the same operator should be considered suspect if they differ by more than 7 percent of the mean.

D-5.1.2 *Reproducibility* — The results submitted by each of two laboratories should be considered suspect if they differ by more than 9 percent of the mean.

APPENDIX E

(*Clauses* 6.1 *and* 9.2.4)

PRECAUTIONARY STATEMENTS

E-1. *iso*-OCTANE

Danger — Extremely flammable.
Harmful if inhaled. Vapours may cause flash fire.
Keep away from heat, sparks, and open flame.
Keep container closed.
Use with adequate ventilation.
Avoid buildup of vapours and eliminate all sources of ignition, especially nonexplosion proof electrical apparatus and heaters.
Avoid prolonged breathing of vapour or spray mist.
Avoid prolonged or repeated skin contact.

E-2. DECAHYDRONAPHTHALENE (DECALIN)

Caution — Combustible. Vapour harmful.
Keep away from heat, sparks, and open flame.
Keep containers closed.
Use with adequate ventilation.
Avoid breathing vapour or spray mist.
Avoid prolonged or repeated contact with skin.

E-3. CYCLOHEXANE

Danger — Extremely flammable.
Harmful if inhaled. Vapours may cause flash fire.
Keep away from heat, sparks, and open flame.
Keep container closed.
Use with adequate ventilation.
Avoid buildup of vapours and eliminate all sources of ignition, especially nonexplosion proof electrical apparatus and heaters.
Avoid prolonged breathing of vapour or spray mist.
Avoid prolonged or repeated skin contact.

E-4. CHLOROFORM, CARBON TETRACHLORIDE

Danger — May be fatal if swallowed.
Harmful if inhaled. May produce toxic vapours if burned.
Keep container closed.
Avoid prolonged breathing of vapour or spray mist.
Avoid contact with eyes and skin.
Do not take internally.
Use with adequate ventilation.

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